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Fuel Cell Membrane Shootout Showcases Hydrocarbon Superiority; PolyFuel Takes on Nafion 117 at Fuel Cell Seminar Demo

SAN ANTONIO--Nov. 1, 2004--PolyFuel, Inc., a world leader in engineered membranes for fuel cells, is running a real-time shootout between one of its revolutionary, hydrocarbon-based direct methanol fuel cell (DMFC) membranes, and Du Pont's Nafion 117, at the Fuel Cell Seminar here through November 4. Utilizing absolutely identical test setups that differ only in the membrane, PolyFuel is running demonstrations continuously over the four-day period. In addition, PolyFuel is showcasing publicly for the first time its recently-announced hydrogen membrane for automotive fuel cell applications in a functioning fuel cell test station.

The DMFC comparison -- which includes continuously-updated cumulative results -- shows that PolyFuel's hydrocarbon DMFC membrane has substantially improved performance when compared to the fluorocarbon-based Nafion membrane. In addition, the hydrogen demonstration gives observers a first look at an automotive-focused membrane that operates stably at 95C and 50% air relative humidity, while simultaneously producing "best of breed" power levels -- a performance combination that has never been achieved before with other materials.

Fuel cell membranes, which resemble ordinary plastic wrap, are the critical component that permits electricity to be generated directly from hydrogen or hydrogen-rich fuel sources in cells that can power anything from cellular telephones to laptop computers to automobiles. Direct methanol fuel cells, which utilize readily-available methyl alcohol as fuel, are expected to offer a long-run-time alternative to batteries for mobile electronics applications. Such cells, and their small, exchangeable fuel cartridges, will snap into such devices much as batteries do today. Hydrogen-based fuel cells are believed by many to be the best long-term power solution for motor vehicles as fossil fuels become less available, and as environmental and political concerns escalate.

"The performance of a fuel cell membrane determines whether or not the cell will be practical in any given application," says Dr. Robert F. Savinell, dean of engineering at Case Western Reserve University and George S. Dively professor of engineering. "PolyFuel has achieved a combination of performance characteristics that are impressive, and the benefits of their groundbreaking work will be readily apparent in their demonstration at the Seminar."

Fuel cell membranes -- technically "proton exchange membranes" -- use a catalyst coating such as platinum to coax electrons away from their companion protons in hydrogen atoms in the fuel. The membrane permits the protons to cross through it -- the exchange -- but the electrons cannot. Instead, they flow out the terminal of the fuel cell, through the load to do work, and then back into the opposite side to recombine with protons and oxygen to make water. Water, heat, and in the case of DMFC, carbon dioxide, are the only byproducts of this reaction.

What has proven problematic for fuel cell designers is that existing membranes, particularly the most commonly available perfluorinated or fluorocarbon membranes such as Nafion have several severe limitations.

For example, existing DMFC membranes essentially "leak". The methanol fuel on one side of the membrane crosses over to the air side of the fuel cell, where it creates troublesome excess heat and water. This increases fuel consumption significantly. With higher concentrations of methanol -- desirable from a fuel efficiency and runtime perspective -- the crossover is even worse. In addition, existing DMFC membranes require significant amounts of water to achieve good performance, diluting the concentration of the fuel, which increases the size of the fuel cell and reduces overall energy density.

Existing hydrogen membranes, for their part, suffer from operating range and life limitations. Today for example, they operate comfortably only within a narrow temperature range of 0C to 80C, not low enough to be able to start a car in wintertime, and not high enough to be able to reach full power in summertime. As well, today's fluorocarbon membranes require high levels of

humidification (typically 80% relative humidity (RH) or above), which increases engine size and complexity. Each of these factors makes the material problematic in automotive applications, preventing the fuel cell vehicle from being competitive with today's internal combustion engine vehicles. In addition, fluorocarbon membranes are structurally weak, limiting the in-service lifetime of today's fuel cell engines to well below the automotive requirement of 5000 hours.

PolyFuel's Membranes and the DMFC Membrane Shootout

PolyFuel is the world's first pure-play membrane company with the technology to directly engineer membranes to end-user requirements. Some time ago, its scientists and engineers concluded that fluorocarbon-based membranes would never achieve the cost or performance figures sufficient to yield small, lightweight, and inexpensive fuel cells that could significantly outperform the batteries they were intended to replace, nor live up to the stringent operating requirements that are characteristic of automotive applications.

Instead, the company engineered several new families of membranes based upon hydrocarbon polymers, which PolyFuel has found to be intrinsically cheaper, stronger, and better performing than their fluorocarbon cousins. Two breakthroughs have resulted from this pioneering work -- the PolyFuel DMFC membrane, and the new PolyFuel hydrocarbon membrane technology for automotive hydrogen fuel cells, recently announced (see "PolyFuel Announces Breakthrough Technology Advance for Automotive Fuel Cells," http://www.polyfuel.com/pressroom/press_pr_100504.html, October 4, 2004.)

In the shootout, which PolyFuel calls the "DMFC Challenge Demo," the PolyFuel hydrocarbon DMFC membrane and the Nafion 117 membrane have been built into otherwise identical "brassboard" test setups. The test setups permit observers to easily monitor fuel consumption as well as gross and net power, and wastewater production in real time, during the 20-minute demonstration. In addition, PolyFuel is continuously updating the cumulative results over the 4-day show. Operating conditions for the two setups -- including output current, air, and fuel concentrations -- are identical, as well.

A few feet away, a single cell test setup is demonstrating a working hydrogen fuel cell with the new PolyFuel hydrogen membrane.

Unprecedented Results

Seminar attendees will observe that the PolyFuel DMFC membrane produces 15% more net electrical output than Nafion 117 while consuming 25% less fuel, and does this producing 55-60% less waste water, with 30% less heat, and consuming 55-60% less water. Based upon 110 cc of methanol fuel (about 3.7 US fluid ounces), a laptop computer using an average of 15 Watts could be expected to run eight hours, 35% longer than with the Nafion fluorocarbon membrane.

In regards to the hydrogen membrane, attendees will see stable production of power at "best of breed" levels, with the cell operating at 95C and 50% air RH.

Jim Balcom, president and CEO of PolyFuel puts both the quantitative results of the shootout, and additional benefits of PolyFuel's hydrocarbon membranes, in perspective. "DMFC manufacturers will be able to use a 1/3 smaller stack, with 1/3 less membrane and 1/3 less catalyst," he said. "Additionally, the water recovery requirement, the heat exchange requirement, and the air supply can all be smaller and less complex. And finally, a higher concentration of fuel, and a smaller fuel cartridge, can be used." These results combine, Balcom stated, to yield portable fuel cell systems that are smaller, lighter, less costly, more robust, quieter, and particularly important -- have longer run times -- than previous approaches.

"On the automotive side," he added, "the outstanding performance of our hydrogen membrane technology will allow fuel cell vehicle designers to more easily engineer fuel cell engines that meet the stringent requirements for motor vehicle applications."

PolyFuel's DMFC membranes are being marketed to portable fuel cell manufacturers worldwide. Balcom reports that virtually every leading fuel cell OEM is testing PolyFuel's DMFC membrane, and are reporting exceptional results. In addition, he said, interest in PolyFuel's new hydrogen membrane by automotive fuel cell vehicle manufacturers is strong.

The Fuel Cell Seminar (www.fuelcellseminar.com) is being held November 1-4, 2004 at the Henry Gonzalez Convention Center, San Antonio, Texas, and attracts over 2,500 attendees.

About PolyFuel

PolyFuel is a world leader in engineered membranes that provide breakthrough performance in fuel cells for portable electronic and automotive applications. The state of the art of fuel cells is essentially that of the membrane, and PolyFuel's leading-edge, hydrocarbon-based membranes enable a new generation of fuel cells that for the first time can deliver on the long-awaited promise of clean, long-running, and cost-effective portable power, based upon renewable energy sources.

PolyFuel's unmatched capability to rapidly translate the system-level requirements of fuel cell designers and manufacturers into engineered polymer nano-architectures has led to its introduction of best-in-class hydrocarbon membranes for both portable direct methanol fuel cells and for automotive hydrogen fuel cells. Such capability -- based on PolyFuel's over 150 combined years of fuel cell experience, world-class polymer nano-architects, and a fundamental patent position covering more than 15 different inventions -- also makes PolyFuel an essential development partner and supplier to any company seeking to advance the state of the art in fuel cells. Polymer electrolyte fuel cells built with PolyFuel membranes can be smaller, lighter, longer-running, more efficient, less expensive and more robust than those made with other membrane materials.

PolyFuel was spun out of SRI International (formerly Stanford Research Institute) in 1999, after 14 years of applied membrane research. The company is based in Mountain View, California, and is privately held. Investors include Mayfield, Ventures West, CDP Capital - Private Equity, Technology Partners, Intel Capital, Chrysalix Energy, Conduit Ventures, KTB Ventures, Horung Venture Partners, Yasuda Enterprise Development, and BiNEXt, a part of the Daesung Group.

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